

path along the surface.

**We claim:**

1. A method for the early detection of electrochemical corrosion, metal and coating degradation utilizing an inexpensive, portable, hand-held, ~~and~~ <sup>flexible</sup> nondestructive corrosion sensor, for detection of corrosion of both small and large coated (painted) and uncoated metal structures, under field <sup>service, or laboratory</sup> ~~(actual, environmental or in situ)~~ conditions, comprising the steps of:

(a) providing a portable, hand-held sensor for producing an output correlative to an identifiable impedance spectrum, (i.e., the impedance magnitude and phase as a function of the frequency of the applied voltage, created utilizing ~~AC~~ <sup>AC</sup> Impedance or Electrochemical Impedance Spectroscopy (EIS)), comprising a pen-like device <sup>a</sup> which consists of a metal tip which serves both as a counter and reference electrode responsive to atmospheric, water uptake, incubation, and corrosion which produce differences in impedance spectra, eliminating the need for a remote or counter electrode by electrolyte immersion; and utilizing, as the working electrode, the metal structure being tested, which either may be coated or uncoated;

(b) utilizing the sensor, ~~which may be either straight in structural configuration (in the form of a pen) or bent in a curved or angled fashion to achieve better access through small openings,~~ as the counter or reference electrode and pressing the metal tip of the sensor against the <sup>surface</sup> ~~top coat~~ of the metallic structure to be tested, a small electrical voltage is applied between the metallic substrate of the structure, which serves as the working electrode, and the pen-like sensor, and measuring the resulting current based upon the applied voltage between the

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electrodes;

(c) controlling the detection area of the sensor by wetting the surface of the structure with water or other electrolyte allowing the sensor to detect corrosion or coating defects away from the sensor wherever the structure is wet.

(d) converting an analog signal indicative of the measured current to a corresponding ac impedance signal;

(e) providing a ~~potentiostat's~~ <sup>controlled potentiostat</sup> microcomputer with an operational program representative of a functional expression which correlates to distinctive impedance signatures; and

(f) <sup>comparing</sup> ~~converting~~ the impedance spectrum as a function of accelerated exposure and interpreting the said spectrum to determine the stage of corrosion the metal and/or coating has experienced.

2. An apparatus for detection of metal and coating degradation of any metallic structure under field <sup>service, or laboratory</sup> ~~(actual, environmental or in situ)~~ conditions, based on an identifiable impedance spectrum i.e., the impedance magnitude and phase as a function of the frequency of the applied voltage created utilizing ac impedance or Electrochemical Impedance Spectroscopy (EIS) comprising:

(a) means for measuring impedance spectra by applying electrical voltage between the metallic substrate of the structure as a working electrode and a counter or reference

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